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GEOLOGICAL SURVEYS IN ALABAMA.

First Survey.

Upon the appointment of Professor Michael Tuomey, in 1847, to the professorship of Geology in the University of Alabama, it was made a part of his duty to spend such portions of his time, not exceeding four months in each year, in exploring the state in connection with his proper department, as the Trustees might consider for the advantage of the state. Professor Tuomey, in accordance with these instructions, began immediately his explorations, and thus the first systematic examination of the geology of Alabama was instituted. Such extracts from his reports to the Trustees upon this work as were considered of general interest, were published from time to time in the newspapers of the city of Tuscaloosa, and in January, 1848, the state legislature made recognition of this effort by appointing Professor Tuomey State Geologist, and requesting him to lay before them the results of his explorations, to be published by the state. Thus was begun the first geological survey of Alabama. From 1848 to 1853 Professor Tuomey continued these explorations at the expense of the University of Alabama, the state having made no appropriation for the purpose, and in 1849 he presented to the legislature his first biennial report, which was published in 1850 by the state. The geological map was not ready, however, for distribution with the report, and appeared separately. When we consider the great number of observations recorded in this volume, and the accuracy with which the limits of the various geological formations were laid down upon the map, after only two years' exploration, in a state about whose geology almost nothing was previously known, we cannot fail to recognize the genius of the man.

In 1854 the legislature passed a law appropriating $10,000 for the support of the Geological Survey, and an additional sum of $2,500 per annum for the salary of the state geologist. Under this law Professor Tuomey was appointed State Geologist by Governor Winston, resigned his position in the University, and devoted his whole time to the survey till about 1856. During the two years, however, of his service to the state he still kept his office at the University of Alabama, and delivered lectures to some of the classes of that institution. During this time he was assisted by Professor E. Q. Thornton, O. M. Lieber and others, and in 1855 Professor John W. Mallet was appointed Chemist to the survey. The results of the labors of Professor Tuomey and his assistants were brought together by him in a report which was submitted to the legislature in November, 1855, but, by the negligence of the state printers, and for other reasons, the publication of this report was delayed for more than two years. The appropriation for the survey being exhausted, Professor Tuomey resumed his work at the University in 1856, intending to devote his leisure time as before to the survey, and especially to the elaboration of his notes. The summer of 1856 was devoted to field work, but his death occurred the following year 1857, on March 30.

Upon the death of Professor Tuomey, Dr. Mallet undertook the task of editing and bringing out the long delayed report It was found that part of the manuscript had been lost, some of it was incomplete, and thus a large amount of valuable material was lost to the state and to science. In September, 1858, this Second Biennial Report at last appeared, accompanied by another map of the state, more detailed than the first. After the death of Professor Tuomey, in 1857, the survey was discontinued.

From 1868 to 1876 a Commissioner of Industrial Resources was one of the regular officers of the state government, and four small pamphlets were issued from that office, but the Legislature of 1874–5 practically abolished the office by making no appropriation for the salaries of the Commissioner and his Assistant, and in the code of 1876 no provision was made for the continuance of the Bureau.

Second Survey.

First Decade.—In the meantime, upon the reorganization of the University of Alabama, in 1871, after a "reconstruction" régime of five years, the Board of Regents of that institution again took the initiative in re-establishing the Survey by requiring the Professor of Geology to devote as much time in traveling over the state, in making examinations and collections in geology, as would be consistent with his duties at the University.

In pursuance of this ordinance, the present writer, who at that time filled the chair above mentioned in the University, spent a part of his vacation in 1871, at his own expense, in the examination of certain marine Tertiary deposits in Clarke, Washington and Choctaw counties.

The subject of the Geological Survey was brought before the legislature of 1872–3, and an act was passed by them in 1873, reviving the survey, naming Eugene A. Smith, State Geologist, and making an appropriation of $500 per annum for the expenses of the survey, and an additional appropriation of $3,000 for an outfit for chemical laboratory, and traveling and camp equipments. In 1877 a bill was passed making a biennial appropriation of $200 for the purpose of preparing maps and other illustrations for the geological reports. Another special appropriation of $250 was made in 1879 for the same purpose.

During the ten years from 1873 to 1882 inclusive, the writer devoted the greater part of the three months of each summer vacation to geological excursions, receiving no compensation therefor in the way of salary. The actual traveling expenses were, however, defrayed out of the annual appropriation of $500, which also paid the other contingent expenses of the survey. In the summer of 1878 Mr. Henry McCalley, at his own expense, accompanied the writer in the field, and during the following years, from 1879 to 1882, he undertook independent field work, without compensation from the survey beyond the payment of his expenses while in the field. At this time he held the position of Assistant in the Chemical Department of the University, then also under the charge of the present writer. There were other volunteer assistants during this time; the two whose contributions are to be found in the survey reports being Professor W. C. Stubbs, who made a number of chemical analyses, besides taking part in the field work, and Mr. T. H. Aldrich, who prepared a valuable sketch of the early history of coal mining operations in Alabama, published in the report for 1875.

Publications.—During this period of ten years there were published four annual reports, viz., for 1873, 1874, 1875, and 1876, and three biennial reports, viz., for 1877–8, 1879–80, and 1881–2.

With the exception of the Agricultural report of 1881–2, these were of the nature of preliminary or reconnoissance reports, and they deal chiefly with the economic features of the state. The report for 1873 was a mere statement of the plan of the work proposed. That of 1874 is concerned with the crystalline region, and particularly with the copper-bearing strata. At the time when the examinations were made there, the whole section was greatly interested in the subject of copper, just as now it is interested in gold. A part of the next report, 1875, treated of the same subject, but the greater part of it was devoted to the examination and classification of the Valley formations, of Jones' Valley and the great Coosa Valley region. Professor Tuomey recognized the occurrence in these valleys of the Silurian, Devonian, and Subcarboniferous formations, without undertaking the subdivision of the same, except in the case of the Clinton and Trenton. During the summer of 1875, it was possible for the writer to establish the practical identity of these formations with what had already been so clearly described for Tennessee by Professor Safford, and he established the fact of the existence in Alabama of the Ocoee, Chilhowee, Knox Sandstone, Shale and Dolomite, the Lower and Upper Subcarboniferous with their respective minor divisions. The report for 1875 contained also the sketch of the early history of Coal Mining in Alabama, to which reference has already been made above, and there were also presented the records of the borings by diamond drill in the different parts of the Warrior Field together with an attempt at correlating the same. The report holds also many details of the occurrence and composition of iron ores and limestones of this district. The report for 1876 continued the examination of the valley regions, and contained a paper on the Alabama fresh water shells by Dr. James Lewis, contributed by Mr. Aldrich.

In 1877–8 attention was turned to the Warrior Coal Field, till then comparatively unknown, and maps were published of Walker, Fayette, Marion, and Winston counties, which were practically underlaid with Coal Measures. Notwithstanding the fact that no coal was mined at that time in all this region, and it was not possible with the means at the disposal of the survey to open the seams so as to show their true value, the publication, especially of these maps, turned the attention of investors to these counties, and the next few years witnessed marvellous developments there.

In 1878–9 a movement was set on foot to secure an appropriation from Congress for the purpose of making navigable the Upper Warrior river to develop the coal seams along its course, and the writer, with Mr. McCalley and Mr. Jos. Squire, ran a line of levels from the forks of the Warrior down to Tuscaloosa, and made special re-examination of the coal seams within available distance from the river. The expense of this survey was borne chiefly by the War Department, but the map and report were published by the survey. In this document the details of the coal seams were given with a much greater degree of fullness than heretofore, together with many facts bearing upon their stratigraphical relations. In this volume was also a continuation by Mr. McCalley of the description of the Tennessee valley, begun the year before by Mr. McCalley and myself; together with the analyses of some 50 specimens of coal from the Warrior field.

In 1880 the writer was requested by Dr. Hilgard to prepare for the Tenth Census a report on Cotton Culture in Alabama and Florida, and in 1883 was published the state report, embracing the results of these observations in Alabama. In addition to the special descriptive matter, this report contains a general discussion of the composition, mode of formation, and properties of soils and of the changes produced by cultivation. The maps showing the agricultural divisions of the state, and showing the relations between the area cultivated in cotton and the total area, were prepared for the Tenth Census, but the survey had the privilege of using the plates. The other illustrations were prepared by the survey. This report deals in some detail with the agricultural divisions of the state, and contains many analyses of soils and marls, made partly by the Census and partly by the geological survey.

In the case of the two reports last named, advantage was taken of opportunities in which work done by the writer for other organizations could be turned to the direct benefit of the survey, thus securing much fuller reports and better illustrations than would have been at all possible with the survey funds alone.

Cost.—The printing of these reports was paid for out of the general printing fund of the state, at a cost of $6,750, and this, added to the $8,000 directly appropriated to the survey for equipment, field work, and all other purposes, gives $14,750 as the total cost of the survey during these ten years; an average of $1,475 per annum.

Before going further it may be well to consider what was accomplished during this decade, to point out the advantages derived from this long period of preliminary work, and to call attention to some of its manifest disadvantages.

1) Every county in the state was visited, and the main features of the geology and resources of each were ascertained; descriptions were published of each of these counties, in some cases giving much detail; the main subdivisions of the geological formations in the state were established; the mode of occurrence and general distribution of the most important mineral resources were described and illustrated by many analyses; and the agricultural features of the entire state were given with an approach to completeness, thanks to the coöperation of the Tenth Census.

2) The experience and the knowledge of the territory acquired

by the state geologist during this long period, have unquestionably since been of benefit to the state, for without such experience on his part the disbursing of large sums and the directing of the work of the enlarged survey, so as to secure the best results and to avoid injudicious expenditures, would have been attended with many perhaps insurmountable difficulties. I might add further that the cost to the state of this preliminary work, as shown above, was small.

3) On the other hand, while at the beginning of the work these preliminary reports supplied in a measure the information then demanded, it cannot be denied that the progress of the state in the development of its great resources, especially in the latter part of this period created a demand for much more detailed and special information in certain directions than the survey could supply without some greater expenditure of money.

Second Decade.—Accordingly, a bill was brought before the General Assembly of 1882–83, providing for an annual appropriation of $5,000 for the ensuing ten years, and this bill became a law in February, 1883. Before the expiration of this ten-year limit the amount of the annual appropriation was increased in 1891 to $7,500; to continue till otherwise ordered by the General Assembly, thus avoiding the necessity of renewed legislation at every meeting. Under these laws assistants were appointed and work assigned as follows. Henry McCalley, in the Warrior Coal Field and subsequently in the Valley regions; Jos. Squire, in the Cahaba Coal Field; A. M. Gibson, in Murphree's Valley and the Coal Measures adjacent thereto, and afterwards in the Coosa Coal Field; the State Geologist, with D. W. Langdon, T. H. Aldrich, and L. C. Johnson, undertook the examination of the Cretaceous and Tertiary formations of the Coastal Plain. Administrative work, the editing of reports, and the preparation of the Geological Map, have however engrossed a great part of his time. Later, Dr. George Little made an examination of the clays of the Lower Cretaceous; Dr. W. B. Phillips began the investigation of the Gold region, and Mr. K. M. Cunningham has demonstrated the existence of true chalk deposits in our Cretaceous formation.

Geological Reports published or in preparation.—Departing from the strict chronological order we shall state briefly the work accomplished and in hand in each of these divisions.

In 1886 was published McCalley's Report on the Warrior Coal Field, containing detailed sections of all the exposures of coal seams in the basin division of this field, together with Mr. Gibson's account of part of the plateau division. This report also contains the first approximately full columnar section of the measures of this field. In 1891 appeared McCalley's report on the Plateau region of the Warrior Field with map and colored sections. Mr. Gibson also contributed to this volume.

Active work has also for the past three years been going on and is still in progress under Mr. McCalley's direction in the Warrior Basin, in locating accurately the surface outcrops of the important coal seams. His examination of the Valley regions and their economic products, including iron ores, limestones, building stones, and bauxites, has been in progress for the past five or six years, and his report thereon is in great part written up.

In 1890 was published Mr. Squire's Report and Map of the Cahaba Coal Field. This document is the outcome of about thirty years'work, during which time Mr. Squire has been continuously engaged in this field either in active mining or in making instrumental surveys for individuals or corporations, all the results of which have been incorporated in his report. The map shows accurately the surface outcrops of all the important seams of coal, and a number of carefully constructed vertical and horizontal sections of the field. It exhibits also the geology of the adjacent valleys, compiled mainly from Mr. McCalley's notes by the present writer, who has also added a description of these formations and a sketch of their accumulation and subsequent history.

In 1884 the existence of phosphatic nodules and marls was discovered. The distribution, quality, and quantity of these materials were pretty thoroughly investigated by Mr. Langdon and myself, to form part of the coastal plain report; but the holding back of this report for the map, and on account of active work in progress in the lower part of the state which it was desirable to incorporate therein, led us to issue in 1892, as Bulletin No. 2, an account of these marls in separate form.

In 1893 appeared Mr. Gibson's report on the Geology and Resources of Murphree's Valley, the publication of which had been delayed on account of the lack of a suitable map for its illustration. His report on the Coal Measures of Blount Mountain has just been published, 1894, and he is at work upon a preliminary report on the Coosa Coal Field.

Dr. Wm. B. Phillips, in 1891, undertook the examination of the gold region, spent part of one summer in the field work, and prepared a partial report thereon, but was unable to complete this work, and it was taken up in 1893 by myself and Mr. W. M. Brewer. It has been conclusively shown that these fields, with suitable methods of extracting the gold, can be worked in many places at a profit. The great activity now prevailing there leads us to think that the mining of gold will soon take an important place among the industries of the state.

Coöperation of the U. S. Geological Survey. Soon after the consolidation of the United States Geological Surveys into one organization in 1879, propositions were made by the director for coöperation with the state surveys, in accordance with which it was agreed that the U. S. Survey should make in Alabama accurately measured sections of our Paleozoic formations at two points selected after full consultation. This plan was afterwards slightly modified, and the results were published in 1892 as Bulletin No. 4 of the State Survey, a Report on the Geology of Northeastern Alabama and the adjacent parts of Georgia, by C. W. Hayes. This region in Alabama had already been pretty closely examined by the state survey, so that the change in the original plan caused some degree of duplication of work, but the mode of treatment of the subject and the map showing the connection with Georgia make this an exceedingly acceptable contribution.

Another result of this coöperation was a trip in 1883 down the Warrior and up the Alabama rivers, made by L. C. Johnson and myself at the joint expense of the State and National Surveys, during which we collected the data for the first attempt at the stratigraphy of the Cretaceous and Tertiary formations of our Coastal Plain. The greater part, however, of the material afterwards brought together by the writer and published as Bulletin No. 43 of the U. S. Survey was collected in the following seasons, 1884–5–6, by the Alabama survey alone, by Messrs. Langdon, Aldrich and myself. Mr. Langdon afterwards carried these examinations across the state to the Georgia line, and thence down the Chattahoochee to Bristol, Fla., when he made the discoveries of the Chattahoochee and Alum Bluff series of Miocene formations, which have since become famous localities.

Although the joint trip of the present writer and Mr. Johnson, above mentioned, occupied only two weeks' time, Mr. Johnson was afterwards assigned by the U. S. Survey to independent work in this territory, especially in the examination of the post-Eocene formations, and it is to his work that we owe the greater part of our knowledge of the Grand Gulf and Pascagoula Miocene of this state. Mr. Johnson was also for one season in the employ of the state survey in completing the work thus begun. The present writer has also spent an additional season in this territory in 1891, and the coastal plain report above alluded to will contain the notes from all these sources.

It was feared by many that the extension of the U. S. Survey into the territories of the older states would have the effect of preventing the organization of new state surveys, and of causing the discontinuance of those already in existence, but the continuance or completion of existing surveys in New Jersey, Minnesota, Illinois, Indiana, Pennsylvania, Kentucky, Alabama and Wisconsin, and the organization of new surveys in Texas, Arkansas, Missouri, Georgia, North Carolina and Iowa show that these fears have not been fully realized. The national and state surveys occupy practically somewhat different ground, and so far from being antagonistic, they should be mutually helpful. In the case of Alabama it may be asserted that the coöperation of the U. S. Survey has been very distinctly advantageous. In retrospect one can, however, easily see how these benefits might have been materially increased by more frequent conferences and consequently more thorough mutual understandings and adjustments.

Paleontology and Natural History.—With the small amount appropriated for the survey it would have been injudicious to use any of it on paleontology, but Mr. T. H. Aldrich contributed, without cost to the state, Bulletin No. 1, published in 1886, containing descriptions of new Tertiary fossils, with nine plates of illustrations. This is the first installment of what is designed to be a complete and illustrated account of our Tertiary paleontology.

So also Professor Herrick, of Denison University, contributed a List of the Fresh Water and Marine Crustacea of Alabama, with Descriptions of New Species, which was published by the Survey in 1887, as Bulletin No. 1 of Vol. V. This paper, which also appeared as a Memoir of the Denison Scientific Association, is illustrated by eight plates of figures of the species described.

From the beginning of the survey collections have been made by myself of the native plants of the state, and these collections, combined with those of Dr. Charles Mohr, of Mobile, were by him arranged and mounted, and the joint herbarium deposited in the cabinet of the University of Alabama. A preliminary list of the Alabama flora was printed in 1880, and Dr. Mohr is now engaged in preparing for the survey a report on the Botany of the state, in which every known indigenous phænogamous plant and fern will be listed, and full accounts given of the timber, forage, useful and noxious plants. The geographical distribution of the Alabama flora and the mapping of the botanical provinces of the state will be a valuable feature of this report, which is now far advanced towards completion.

In the progress of the work a new species of Croton of shrubby habit, *C. Alabamensis*, has been discovered, and many rare plants have been found growing upon our soil.

Geological Map.—Lastly, the preparation of the geological map of the state has engrossed a large part of the time and attention of the state geologist for several years. The first difficulty to be overcome was the lack of a suitable base map. In this we had the aid of the U. S. Survey, in which office was compiled the first base map printed by the survey. As the work progressed numerous alterations and corrections became necessary, and not until 1893 was a satisfactory base map prepared. This map, on a scale of ten miles to the inch, with colors to show the geology, will be ready for distribution in a short time. It will be accompanied by a chart exhibiting the main lithological, economic, topographic and agricultural characters of each of the formations represented, and will embody the results obtained during the past twenty-one years.

Cost.—The cost of the survey during this period of eleven years, 1883–1893 inclusive, has been as follows:

Eight annual appropriations of $5,000	$40,000.00
Three annual appropriations of 7,500	22,500.00
Printing, binding, illustrating, and distributing reports	13,347.00
	$75,847.00

the entire cost averaging about $6,900 per annum. For the whole period of 21 years during which this survey has been active, the aggregate cost of the survey for all purposes has been $90,597, an average of $4,314 per annum.

Economic results.—Since the organization of the survey, the tax rate has been reduced over 50 per cent., without diminishing the revenues. The increase in the value of property in certain sections of the state that has rendered this possible, has been due in the main to the development of the mineral wealth of the state, and to this the survey publications have contributed a certain share, but how much it would of course be impossible to estimate. In this connection, however, it may be proper to say that some of the regions of the state in which the mining of coal and iron have since assumed vast proportions, were practically untouched by the pick of the miner, when our earlier reports directed attention by maps, analyses, and otherwise to their great resources: and very recently the survey has demonstrated the existence, within the Coal Measures, of certain areas heretofore untried, in which the mining of coal will undoubtedly be profitable ; it has pointed out a source of wealth in the phosphatic marls of certain sections ; it has shown that gold may be mined with profit at many points within our limits ; it has demonstrated the fact that clays suitable for the manufacture of fine porcelain ware, fire-brick, tiles, and other articles, occur in practically limitless quantity in many sections ; it has pointed out the localities where good marbles and building stones may be had for the quarrying ; all these have as yet not been turned to account.

Unsolved problems.—Of the problems of geological interest, developed in the course of the survey but not yet settled, I may mention the following : The stratigraphic relations of some of our Lower Cambrian formations are still uncertain ; the relations between the formations of unquestioned Cambrian age, and the gold-bearing semi-crystalline strata adjacent to them and in some instances interlocking, are yet to be definitely fixed ; the correlation of the seams of our three coal fields is still an unsolved problem, at least in its details.

Work yet to be done.—After the issue of the publications now in hand, the most important items of work proposed, are 1) The accurate mapping of the outcrops of all the coal seams of economic importance. The finishing of two or three of the sheets of the U. S. topographical survey will render this comparatively easy. 2) The preparation of county maps on the scale of half an inch to the mile, with accurate locations of all mineral deposits, mines, etc., as well as of the geological formations. 3) A republication, or rather a new edition, of the Agricultural report, with a map showing the distribution of the soil varieties. 4) An investigation of the water supply of the Coastal plain region, with special reference to Artesian borings. Much of the material for this is already in hand and in part published.

EUGENE ALLEN SMITH.